VTT Technical Research Centre of Finland

Demand Management for Future Electricity Market

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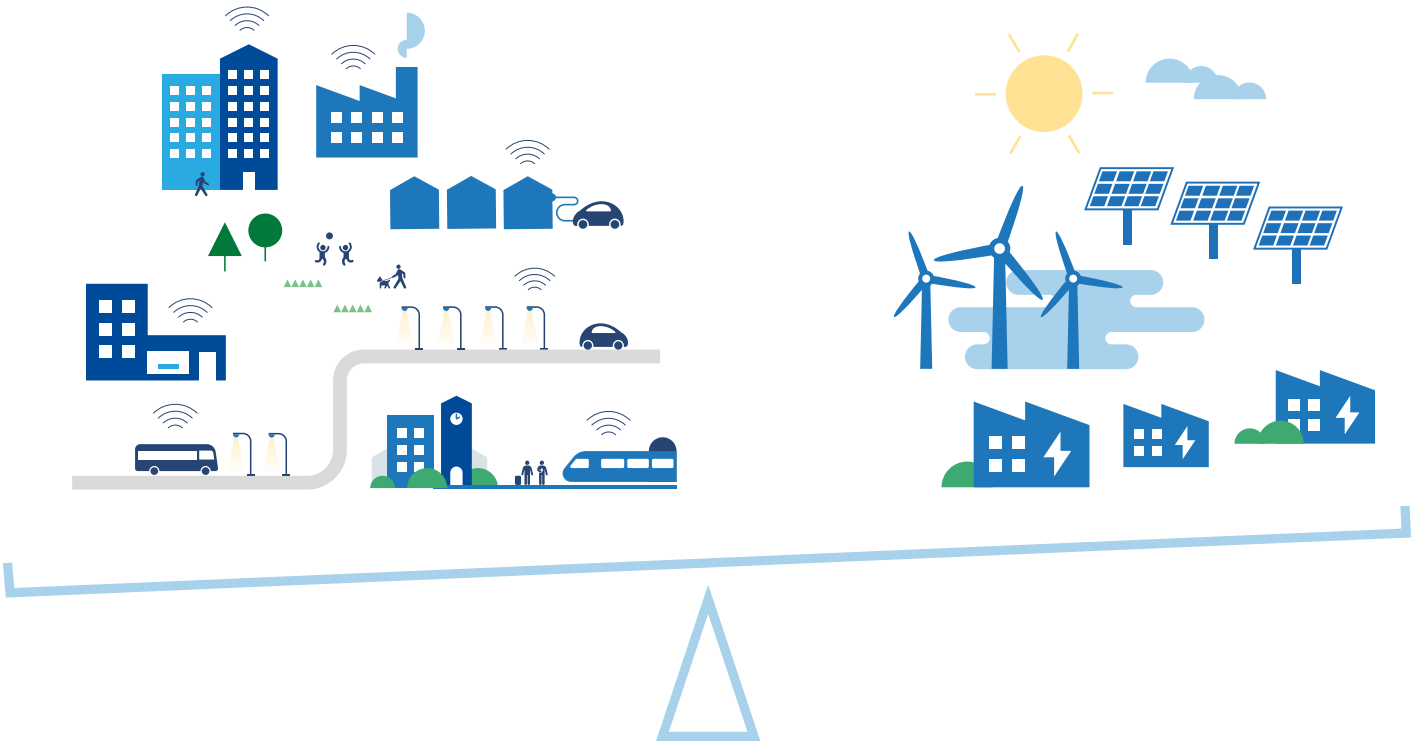

Technical Research Centre of Finland VTT Oy
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Summary

The society is electrifying at an accelerating pace and this creates demands for adjusting the consumption of electricity. Electricity is used in new ways e.g. in heat pumps and charging electric cars. In addition, the increase in renewable production methods such as solar and wind power poses new challenges for electric systems. Momentary consumption peaks caused by these phenomena burden both production and supply of electricity and this becomes expensive for the society.

One solution for dealing with the peak moments is to create better circumstances for demand-side management. More buildings and electricity consumers should have impact in how much they consume and when. This way the society's whole consumption and unwanted emissions can be controlled.

Digitalization acts as a significant catalyst and enables new ways of operating also in electricity markets. It can already now be seen that new players are entering the electricity market eco-system. This introduces new disruptive business models to the market and creates new kinds of services for the end customers. This has happened in many other business domains: Spotify disrupted the distribution and consumption of music. AirBnB has reshaped the hotel industry and Uber is changing the taxi business. Who will lead the electricity market?

Electricity market will for sure change by virtue of the new business models enabled by the Internet. Producing and supplying electricity is very investment intensive and critical for the society. That is why digitalizing the electricity and power market must be executed in a very controlled matter and in commonly agreed terms.

VTT proposes the following actions to be taken for ensuring Finland's autonomy in electric markets:

Investing in demand-side management in order to create more supply from adjusting power

Managing the consumption and production of electricity over the internet, in a manner that is open to competition

Utilizing IoT for unleashing the latent adjusting potential in buildings

Creating a market place for adjusting power, which can be used to ensure reliable functioning of electricity networks

Adjusting Power, Demand Management, and Electricity Network

Adjusting power refers to the production of energy/electricity, which can react to changes in the balance between production and consumption. With current technology electricity cannot be stored to large extent so basically the amount of electricity produced at any given time has to be roughly the same as the amount consumed.

Adjusting power is related to another concept, namely **demand-side management**, which means reducing, increasing, or transferring the demand of electricity. The goal is to ensure cost-effective operating of a building or a larger residential area.

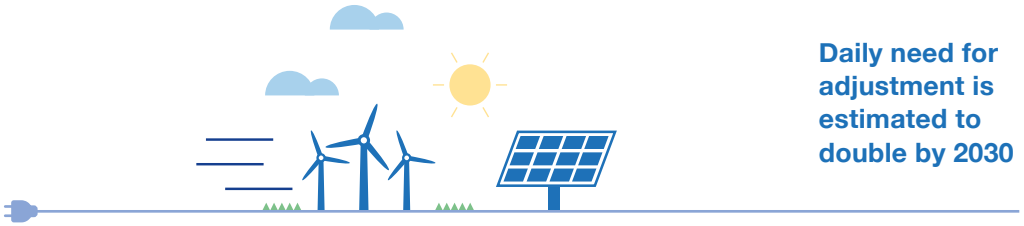
Traditionally the only network electronic devices (except computers) have been connected to is the electric network. The Internet of Things (IoT) is changing this. It enables all kinds of devices to log on the Internet. By doing this they can report their own consumption and even allow external control of their own consumption. Combining the Internet and an electric network like this is called an **intelligent network**. When implementing an intelligent network, extra attention should be put on security aspects.

The Importance of Adjusting Power to Finland

The need for adjusting power is estimated to significantly increase in Western and Northern Europe in the years to come. This is because a large proportion of thermal-based power production will stop. At the same time the share of weather-dependent wind and solar power will increase. Finland discharged 2450 MW of condensing power adjustment capacity in the years 2015-2017 alone. The need for adjustment is also driven by the electrification of society, which will accelerate in the future for example by virtue of electric vehicles. For maintaining adjusting power, the EU has planned capacity payments, which will amount to tens of billions of euros annually. The purpose of this is to maintain aging condensing power production.

If the national wind power goals will realize, an hourly adjustment need in Finland is estimated to increase approximately 400 MW by the year 2020 [Finnish Energy 2016]. It is noteworthy that aggressive investments in wind power will continue in neighboring countries and it will have impact in Finland buying adjusting power for example from Sweden.

Daily need for adjustment is estimated to double by 2030 [Finnish Energy 2016]. At the moment the majority of Finnish adjusting power is created from water power or imported from other Northern countries, which have easily adjustable water power production.



Daily need for adjustment is estimated to double by 2030

Demand-side Management Reduces the Need for Investing in Extra Production Facilities

The balance between production and consumption of electricity can be reached via storing electricity or demand-side management. In demand-side management the demand of electricity is increased or decreased so that the change will result in reaching the balance between production and consumption. Demand-side management can transfer the demand to another moment in time when the price and availability are better for the customer. When the consumption of electricity is decreased, one can also use the term consumption management.

There are already several market places for adjusting power created with demand-side management:

- Nord Pool's day ahead (spot) or intraday (Elbas)
- Fingrid's frequency controlled usage reserve (annual market and hourly market) and frequency controlled interference reserve (annual market and hourly market), adjusting power market, prompt interference reserve, and power reserve

Consumption management has a lot of unrealized potential. That is why it is important to lower the barrier for entering the game.

In the present-day market the adjustment possibility of large electricity peaks is already utilized in several market places. This enables effective reaction to interference situations and quick reduction of the demand. Entering these market places however implies large power quantities and expensive automation facilities. These prerequisites restrict new players entering the markets and making solid business with adjusting power.

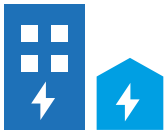
Further developing demand-side management and utilizing it for dealing with demand peaks is nevertheless very important. When the demand-side becomes flexible, the need for producing adjusting power diminishes.

Consumption management has a lot of unrealized potential. That is why it is important to lower the barrier for entering the game and make it easier for smaller newcomers to engage in adjusting power market.

Building Communicating Its Own Power Consumption

Individual buildings and utilizing their adjustment potential is in the core of consumption management. There are over 570 000 electrically heated buildings in Finland, and they consume more than all Finnish nuclear power plants combined produce.

By virtue of the Internet and new digital solutions the **online management** and real-time control of buildings is already possible. A building can communicate information of its own state and whether its energy consumption should be increased or decreased in the minutes or hours to come. Building automation can steer individual devices or processes such as heating, air conditioning, or other energy-intensive activities without weakening the circumstances.



There are over 570 000 electrically heated buildings in Finland

Geographic balancing of electricity consumption calls for detailed information on the distribution of consumption, as well as on peaks which can be controlled. Furthermore, such information should be available from enough buildings for it to have impact regarding broader energy balance. When single buildings are grouped together to an online network, one can speak of **aggregation**.

Aggregation

The information needed for controlling buildings can be described with answering the following questions:

- How much adjustment power there is available?
- For how long the power can be maintained?
- What is the location of the power?

When considering the local energy management possibilities and challenges it is clear that real estate properties need solutions based on commercial control and management. The new system should be designed and implemented so that it is based on effective and automated utilization of the needed information in the electricity market.

Any party offering adjustment services or devices in the future has the need for real-time measuring and controlling of peaks. This way it can optimize the service as needed. Current way of measuring consumption is based on traditional meters and carried out by the supply network. It does not support the optimization as described above. Measuring the supply network however fits the load verification in market places during the measurement period (1h or in the future also 15min or 5min). Shortening the measurement period from one hour to e.g. 15 minutes would enable utilizing also smaller loads in the market.

New Players Entering the Ecosystem

Opening electricity market and demand-side management as well as the supporting digital processes enable implementing more versatile consumer services and the involvement of new parties in the electricity business. The ecosystem will see completely new kinds of **distributors/ aggregators.**

There are already signs of this phenomenon in Europe. For example French and German markets have companies who do not produce electricity themselves at all but merely resell the load of the end users they represent. Utilizing new technology as already disrupted several industry domains and electricity market is no exception. Fast advancement and new operating models create the need for developing an updated legislation for electricity markets.

New Challenges for Developing the Market

A research project called VirpaB has concentrated on demand-side management. The project has unveiled some challenges and questions related to the current market: The role of **aggregator** is somewhat unclear; is the aggregator responsible for ensuring the balance or not? **Network companies** do not have a clear role either. Should they take part in the electricity trade or not? Should **adjustment electricity** have also local markets? How to **measure** adjustment electricity? At the moment there are no strict guidelines for this. Some solution proposals for the above questions:

1. **Aggregator:** As a party involved in electricity trade the aggregator should be responsible in ensuring the balance. If the aggregator acts only as a reseller of the adjustment capacity it does not have to be responsible for the balance. However, then the capacity would be sold to a responsible party or to the market via such party.

2. **Network company:** Could be active local electricity buyer, no incentive in operating outside its local area.

3. **Local markets:** Utilizing location information enables also local adjustment markets, enabling local supply networks to put commercial offering to use.

4. **Measurements:** The verification in the market should primarily be dependent on the current measurement period and verified supply network measurement (under 1h period, for example 15min period, would enable better adjustment and verification capabilities). Periods shorter than 15 minutes could have separate rules as they do today.

Flexibility to the market and clear roles & responsibilities for parties:

In Finland adjustment electricity markets are strongly production-driven. New technologies and operating models enable also real-time consumption management as part of the market. For realizing this, a common online market place for consumption management should be created. The market place should be transparent regarding prices and reaction times. It should also enable cost-effective transactions of small electricity amounts.

Bot trade:

One possible way to implement the market place is to automate trade with bots familiar from stock markets. [A bot is an abbreviation from robot and means a computer program which can operate in an autonomous fashion in terms of the guidelines programmed for it.] Verifying completed transactions can be implemented in an automatic fashion using blockchain technologies.

Bots' activities should be more controlled and regulated than in stock markets so that the reliability of electricity networks can be guaranteed. In addition, a party could get access to a bot only after it has proven to fulfill the security and reliability requirements.

Conclusion

Traditionally electricity markets have been managed and controlled via production. This is not enough anymore and therefore also consumption should be adjusted.

New digital technologies enable several ways to implement market-driven adjustment power using buildings and devices. However, currently Finland does not have the mechanisms for turning consumption management into dynamic business.

It would be important for Finland to create a new online market for adjustment power. In such market place electricity could be bought and sold with very short response times, mimicking those of the stock market. In order to prevent abusive behavior the rules of the market place should be defined carefully and the technology be implemented accordingly.

When implemented right, an open market place for electricity would bring stability and autonomy for Finland and even possibilities for exporting electricity.

The research related to real estate property demand-side management has been carried out in the VIRPAB project funded by Tekes (Business Finland). The project will end in April 2018. In addition to VTT, project partners are the University of Oulu, Fingrid, S Group, Rejlers, Jalecon, Jetitek, Green Energy Finland, Fidelix, and Emtele. The total funding of the project is approximately one million euros.

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